# THE PREDICTION OF SUCCESS IN TRAINING FOR BUSINESS PROGRAMMING STUDENTS

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# THE PREDICTION OF SUCCESS IN TRAINING FOR BUSINESS PROGRAMMING STUDENTS

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A Field Report

Presented to

The Graduate Division

Drake University

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In Partial Fulfillment

of the Requirements for the Degree

Master of Science in Education

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August 1966

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# CHAPTER I

## INTRODUCTION

Some call it the cybernated generation, some the second industrial revolution, but whatever a person wishes to call the advent of the computer, he will have to admit that it has definitely found its place in society. Its varied and sundry uses range from the "way out" task of simulating flights in space to the more "earthly" task of checking income tax returns. At the dawn of this new age, man can be likened to the average American in the early 1900's. He had heard of Ford's horseless carriage and the Wright boys' flying machine, but he was blind to the dimensions of horror and hope which lay before him. By comparison, the machines that have helped make the comic book era of Buck Rogers come alive, stand before men as both friend and foe; friend to the opportunist who recognizes a new era as a chance to "move up" and foe to the men who see themselves becoming a part of a well-known statistic, "one of another 38,000 persons who every week lose their jobs because of automation."[1]

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[1]George T. Harris, "Automation, We Can Handle It," Look Magazine (January 12, 1965), 59-62.

At this moment probably every man, woman, and child in the United States is represented in the memory of one or more electronic digital computers as either a name, number, or statistic. The results of computer processing have a direct influence on most people. Almost every business transaction made ends up, in one form or another, within the circuitry of an electronic computer.

Many of the advantages of computers can be measured only in intangible forms. The nation's health is being protected through the use of these mechanical marvels. Solutions to cancer, heart disease, and other perplexing medical problems are being hastened through the use of computers. America's defense against enemy attack is largely entrusted to computers.

Unfortunately, what the man-on-the-street hears and reads about computers is of the sensational or exaggerated nature. He hears about computers playing chess, tic-tac-toe, gambling, predicting batting averages, and other things that attract the eyes of reporters and the ears of newsmen. Computers are sometimes called brains, when in reality they have an I.Q. of absolute zero. Especially vulnerable to attack are the so-called computer "goofs," despite the fact that it is almost always man who makes the mistake.

Everyone is aware that America has become a nation of producers, consumers, and paper shufflers. One report tells

us that "one out of four production workers is a paper shuffler--an increase of 64 per cent since 1941."[1] "One large chemical company reported that they produced 89 million pieces of paper a year."[2] How, then, can Americans hope to handle the increases of the coming decades and maintain their high standards of living?

The answer, of course, must be through harnessing the powers of the electronic computer.

> We have at our command a tool of magnitude never known before. The tool is getting faster, more compact, more powerful, more flexible and more economical with every passing day. Most important, we are learning how to use it more adroitly. There is no doubt that the Computer Age is here.[3]

As remarkable as the varied uses of computers is the staggering growth of the new industry. Popping up like mushrooms across the United States, the computer is the fastest growing element in the technical arsenal of the world's most technoligized nation. "In 1951 there were fewer than one hundred computers in operation in the United States; today more than 26,000 computers stand in offices, factories, schools, and laboratories."[4]

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[1]Stanley L. Englebardt, Computers (New York: Pyramid Publications, 1962), p. 7.

[2]Ibid., p. 16. [3]Ibid., p. 17.

[4]Computers and Automation Magazine Survey, "Computer Census," Computers and Automation Magazine (March, 1966), 34.

For the care and feeding of these machines a new breed of specialists has appeared. They carry such titles as key-punch operator, tab equipment operator, computer operator, business programmer, scientific programmer, and systems analyst. Their backgrounds range from persons with elementary education and below average intelligence to Ph.D's with varied backgrounds of work experience. This fact alone points out some of the problems inherent in any new area of employment, that of selection and training. Important to counselors desirous of acquiring occupational information are problems of who, how much, and what; who should be trained for the jobs computers have created, how much education and/or training should these persons have, and what criteria should be used to aid persons desirous of determining their abilities and aptitudes for business programming training.

## I. THE PROBLEM

Statement of the problem. It was the purpose of this study to determine the effectiveness of six variables: test scores on the Programmer's Aptitude Test; the G (General Intelligence), V (Verbal Ability), N (Numerical Reasoning), and S (Spatial Relations) scores on the General Aptitude Test Battery; and student age, in predicting success in training for business programming students at the Iowa Technical Education Center, Ottumwa, Iowa.

Reason for the study. How does one select a person who will be successful in a job as a business programmer? The investigator attempted to get an answer to this question by asking employment managers and data-processing managers of six large companies in the Milwaukee, Wisconsin, area in the summer of 1964. Without exception, their first requirement was a college degree, preferably having a math major, plus the second requirement by five of the six companies that the applicant receive an "A" on the IBM Programmer's Aptitude Test (PAT). The sixth company stated that it would accept a grade of "B" on the PAT.

The rationale behind the high requirements was that the programmer is in a natural position to move into the executive level job of systems analyst. The investigator has noted that the trend has seemed to be for lesser educated persons to acquire jobs in programming, probably due to the law of supply and demand.

One of the courses of training that came out of the Manpower Development and Training Act (MDTA) of 1962 was Data Processing. As the Employment Security Commission selected students for this training, they were forced to establish criteria for selection. As the General Aptitude Test Battery (GATB) had been used by the Employment Security Commission with a measure of success for several years, it was only natural that they use this test as their main selection criterion.

By a method unknown to the investigator, they established cut-off scores on five of the sub-tests as follows: General Intelligence - 115, Verbal - 105, Numerical Reasoning - 125, Spatial Relations - 100, and Finger Dexterity - 80. The success of their selection criteria has yet to be established.

Importance of the study. A technologized society can best be described by the word change. The idea of change is not new; what is new is the change in the rate of change. One of the prime causes of change has been the advent of the computer into business and industry. Computers destroy jobs and computers create new jobs. At the same time that technological unemployment grows, there are, by various rough estimates, "Some four million unfilled jobs in the country today."[1] In almost any daily American newspaper a man can read on the front page about the problems of unemployment and turn to the want ads and see that the help wanted section is full of ads. The newly created jobs, however, are not likely to be filled by displaced workers unless they have the educational potential and training opportunities to meet the requirements of the new jobs. Venn stated, "The problem, then, is one of distribution of the labor

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[1]Grant Venn, Man, Education and Work (Washington, D.C.: American Council on Education, 1965), p. 19.

force, of matching job requirements and the potential of people to meet them."[1]

Guidance workers have been criticized for being college oriented, having neither the knowledge nor inclination to help students select an occupation or an appropriate vocational or educational program. Venn commented that "The present inadequacy in guidance activities is illustrated by the fact that close to half of the states receiving federal funds for their programs spend less than 1 per cent of that money on occupational guidance and counseling."[2]

From his experience in a vocational school setting for the past three years, the investigator notes that the vast majority of high school counselors, employment security commission counselors, vocational rehabilitation counselors, as well as other persons working with youth are shamefully ignorant of the data-processing field. Even more shameful is the fact that the majority of these people seemingly make no attempt to up-date themselves in this field.

One aspect of the guidance worker's job is the informational services function. In order to help take some of the guesswork out of vocational choice, the investigator is of the opinion that the counselor should have at his

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[1] Ibid., p. 20. [2] Ibid.

disposal information that would not only aid the student in knowing what duties the worker in a vocational or technical job performs, but also what aptitudes and abilities are necessary to succeed in that job. Such knowledge would enable the student who is desirous of becoming a technician, programmer, et cetera, to receive from the counselor information that would enable him to prepare himself academically, physically, and financially for the work of his choice.

## II. LIMITATIONS OF THE STUDY

Limitations of tests. There are several limitations of psychological tests as tools for gathering information on students. Miller categorized these limitations in three areas: "(1) Those inherent in the tests themselves, (2) those caused by the variety of factors which may influence test performance, and (3) those resulting from improper interpretation of test scores." "Inherent in the tests," Miller said, "are factors that cause inexact and limited measurement."[2] Examples of such factors would be tests of speed or tests requiring good reading ability.

Factors which influence test performance, as stated

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[1]Frank W. Miller, Guidance Principles and Practices (Columbus: Charles E. Merrill Books, Inc., 1961), p. 143.

[2]Ibid., pp. 143-144.

by Miller, are:

> (A) Unusual or adverse testing conditions, (B) worry, anxiety, excitement, or other temporary emotional conditions, (C) hunger, fatigue or other physical conditions, (D) a student's test sophistication or previous experience with similar tests, (E) the degree to which people are motivated to perform to capacity or to answer questions honestly, (F) the ability of the examiner to establish rapport and to administer the test without modification of the test instructions or the time limit.[1]

In the improper interpretation category, Miller stated, "Errors will be made in interpreting test scores unless there is a thorough understanding of the test, its validity, reliability, and the nature of the group on which norms were established."[2]

Barry and Wolfe commented on test limitations in this manner: "All tests are adulterated by factors other than those they were intended to measure."[3] They cited as some of the adulterances such things as reading ability and test experience.

Anastasi argued that the three greatest limitations of tests are motivation, test anxiety, and rapport.[4]

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[1] Ibid., p. 144. [2] Ibid.

[3] Ruth Barry and Beverly Wolfe, Epitaph for Vocational Guidance (New York: Bureau of Publications, 1962), p. 33.

[4] Anne Anastasi, Psychological Testing (New York: The MacMillan Company, 1962), pp. 48-54.

A somewhat different viewpoint was expressed by Smith in his statement that, "Tests assume that people will behave in the future as they have in the past. They assume that the successful people of the future will be similar to successful people of the past."[1]

Limitations of grades. A student who is intelligent may have poor grades because of personality difficulties, and a less intelligent student may get good grades because of certain personality factors and study habits. Along this line, Smith commented on a study by Gebhart and Hoyt (1958) in which they found that ambition is related to academic success.[2]

A very important factor to consider in using grades as a dependent variable is the ability of students to make the adjustment from their former work to training. As the Manpower Development and Training Act students studied ranged in ages from eighteen through fifty-two, it is immediately evident that many of these students had been away from formal study for several years. Many of them had difficulty adjusting to the study demands placed upon them.

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[1]Henry Clay Smith, Personality Adjustment (New York: McGraw-Hill Book Company, Inc., 1961), p. 62.

[2]Ibid., p. 407.

A third factor which would tend to reduce the validity of using grades in predictive work relates to the staff, curriculum, and the use of teaching aids. During the time the investigator has been employed by the Iowa Technical Education Center, he has noted many changes in curriculum within the same class and sometimes by the same instructor. In the field of data-processing there is a minimum number of textbooks available, which means that the instructor, in many instances, must set up his own curriculum. As the instructor sees weaknesses in his offerings, he makes the necessary changes. Changes such as this would, of course, affect the grading procedure. The addition of new and better teaching aids would also have some effect on grades.

One of the factors that would probably affect grades more than any other is that of staff changes. Some instructors take pride in being "tough graders" while others are extremely lenient. Two classes of equal ability taking the same course but having different instructors may end up a full grade apart at the end of a grading period. Factors such as this would tend to reduce the validity of any predictive study in which grades were used.

# CHAPTER II

## REVIEW OF LITERATURE

Information regarding the prognosis of success in training for business programming students is quite limited. The research studies that are available indicate that limitations are present because of the immaturity of the field of data processing.

One of the more prominent instruments used in aptitude testing for data-processing training and employment is the Programmer's Aptitude Test (PAT) published by the International Business Machines Corporation. The PAT manual stated:

> Validity was determined by comparing test scores with a criterion of final class grades converted into standard scores for 175 programming students from various companies in IBM training centers in Boston, Chicago, New York City, and St. Louis in 1959. The product-moment correlations for 11 separate classes ranged from .34 to .85. The correlation computed for the entire group was .51. The mean test score for this group was 50.9 and the standard deviation 14.4.
>
> Table I illustrates the relationship between class standings on final class grades and scores on the Revised PAT. It reveals that 57% of those scoring A on the test were in the highest third of their class, while only 6% of the D's were in the highest third. Conversely, only 13% of the A's were in the lowest third of their class as opposed to 68% of the D's.
>
> In addition to the results illustrated in Table I for the 175 programming students completing their courses, there were 9 students who dropped out of their courses, didn't take the final exam, or who were given a grade of incomplete. Their mean test score was 38.9, 12 points lower than the test score mean of 50.9 for those

completing their courses. This difference was significant at the .02 level of confidence.[1]

TABLE I

RELATIONSHIP BETWEEN REVISED PAT LETTER GRADES AND CLASS STANDINGS BASED ON 650 AND 7070 PROGRAMMING CLASSES (N = 175)

| Test Letter Grade | PAT Score | N | Class Standing: Per Cent in Lowest Third on Final Grades | Class Standing: Per Cent in Highest Third on Final Grades |
|---|---|---|---|---|
| A | 60 and above | 53 | 13 | 57 |
| B | 50 to 59 | 50 | 24 | 42 |
| C | 40 to 49 | 38 | 42 | 13 |
| D | 39 and below | 34 | 68 | 6 |

Another test in wide use is the General Aptitude Test Battery (GATB). The GATB is an outgrowth of the United States Employment Security Commission's occupational research program initiated in 1934. Following extensive research and experimental tryouts, the GATB was introduced nationally to state employment services in 1947. The unique thing about the GATB at the outset stemmed from the fact that it was developed on experimental samples of employed workers performing

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[1]International Business Machines Corporation, Manual for the Programmer's Aptitude Test (New York: International Business Machines, 1955), p. 2.

hundreds of different jobs. The battery proved helpful in working with local office job seekers and plans were made to extend the service to high school seniors. This service proved popular, so the United States Employment Service initiated policy to share the GATB with schools and other non-profit agencies.[1] Several technical institutions offering data-processing training have been using this test instrument. Many of the institutions using the GATB were in agreement with Dvorak in her statement that,

> The battery is useful in counseling persons who are now entrants into the labor market or who are about ready to enter the labor market, those who are considering an occupational change to some field of work in which they have had no previous work experience, and those who are considering vocational training.[2]

McIntosh and Windholtz conducted a predictive study in three data-processing schools in North Carolina. These investigators correlated GATB subscores with achievement test results in five courses as follows: Electronic Data-Processing Systems, Functional Wiring Principles, Fundamentals of Programming, Business Programming, and Scientific Programming.

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[1]Margaret M. Culhane, "The GATB: Its Availability and Use," Vocational Guidance Quarterly, XIII (Autumn, 1964), 63-65.

[2]Beatrice J. Dvorak, "GATB," Personnel and Guidance Journal (November, 1956), 145.

Achievement tests were given the subjects throughout the entire period of study. The authors found correlations with aptitude scores obtained by the GATB and the achievement test scores from the five course programs. The correlations ranged from .02 to .50. The correlation of the GATB variable G (General Intelligence) with the achievement scores ranged from a low of .30 on Fundamentals of Programming to a high of .50 for Scientific Programming. The G score correlation in business programming was .44 which was significant at the .01 level of confidence. Intercorrelations between the achievement scores of the five program courses were reported high. The investigators found that the G variable on the GATB was the best single predictor of achievement in data-processing training.[1]

In a study of the specialty oriented student at the University of Iowa in 1965, Malone found that high correlations existed between the predictor variables mentioned below and the criterion variable, instructor ratings of success in training, for data-processing students. The following correlations were found:

| Predictor Variables | N | Correlation |
|---|---|---|
| Actual H. S. Rank in Class | 51 | .51 |

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[1]William A. McIntosh and George Windholz,"Evaluating Data Processing Aptitude Techniques," Journal of Data Management (May, 1965), 18-20.

| Predictor Variables | N | Correlation |
|---|---|---|
| H. S. Grade Point Average | 57 | .57 |
| H. S. Commercial GPA | 49 | .59 |
| H. S. Math GPA | 57 | .56[1] |

In the same study, Malone used a combination of student characteristics and Daily Vocational Test variables with the dependent variable, instructors' rating, which revealed a correlation of .80. The independent variables were: high school grade-point average, high school commercial grade-point average, Dailey Vocational Test (DVT) Mechanical, and DVT Electronics. Similarly, a combination of Electronics, Science, and Spatial Visualization scores correlated at .57 with instructors' ratings.[2]

Although the PAT was designed initially to aid in selecting programming trainees, research indicates that the test is also significantly related to the performance of programmers on the job.

> In a 1958 study of 41 programmers at IBM in New York City, it was found that the PAT scores and supervisory rankings of overall performance were correlated .44 (significant at the .05 level of confidence).

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[1]Francis E. Malone, "A Study of Students in Post-High School Public Vocational Education Programs in Iowa During 1964-1965" (unpublished Ph.D. thesis, State University of Iowa, 1956), Table 21.

[2]Ibid.

A previous study (1956) of 52 programmers (702 and 705) at IBM in New York City had resulted in a correlation of .36 (significant at the .05 level of confidence) between the PAT and technical performance ratings by the managers on a 5-point scale.

Eastman Kodak in 1958 reported that when supervisors rated 13 programmers on a 6-point job performance scale, the relationship with PAT yielded a Spearman rho of .61, which is significant at the .05 level of confidence.

In a 1958 multi-criteria study of 161 programmers, the Standard Oil Company (New Jersey) found that the PAT correlated .31 with supervisory ratings of overall performance, .28 with technical skills, .37 with imagination and ingenuity, and .33 with learning ability. For other criterion variables relating to such noncognitive factors as interest and motivation, the correlations ranged from -.07 to .26. For this number of cases, a correlation coefficient of .16 or higher is significant at the .05 level of confidence.

In one instance, negative results were reported. The Prudential Insurance Company found in a 1958 study of 43 programmers that the PAT was unrelated to supervisory rankings of job performance (r = .02). No explanation for these results could be found. Since none of the other tests used in this study was correlated with job performance, however, it is possible that some weakness in the criterion used to measure job performance may have been the cause of these results.[1]

The authors of the PAT concluded that:

> The PAT was thus found to be significantly related to overall programming performance in four out of five studies. Evidently, reasoning ability was one of the factors associated with programming performance in a number of companies. The PAT therefore appeared to be a suitable instrument to aid in the selection of programmers.[2]

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[1] International Business Machines Corporation, op. cit., pp. 5-6.

[2] Ibid., p. 6.

A great deal of research has been done using the GATB, with the University of Utah being one of the leaders in this area. In the spring quarter of 1948 this University administered the GATB to 479 seniors, 101 pharmacy sophomores, and 49 second-year medical students. The students selected represented seven different majors: Biological Sciences, Business, Education, Engineering, Social Sciences, Medicine, and Pharmacy. They used as their criterion the students' cumulative grade-point-averages. A correlation was then found between the GATB sub-test scores and the students' cumulative grade-point-averages. The results of this study are shown in Table II.[1]

The second step in this 1948 University of Utah study was to find the mean score of each of the GATB sub-tests for each division and from that form an occupational aptitude pattern (OAP). The method used to come up with the OAP score was the one usually followed with the GATB, which calls for a cut-off point one standard deviation below the mean. The OAP scores obtained in this study are shown in Table III.[2]

The project staff concluded that:

> By testing 479 seniors, 101 pharmacy sophomores, and 49 second year medical students with paper and pencil booklets of the GATB, it was possible to develop an OAP

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[1] GATB Project Staff, op. cit., pp. 137-144.

[2] Ibid.

TABLE II

PEARSON PRODUCT-MOMENT CORRELATION COEFFICIENTS BETWEEN PREDICTOR VARIABLES, GATB SUB-TEST SCORES, AND CRITERION VARIABLE, CUMULATIVE GRADE-POINT-AVERAGE FOR SEVEN COLLEGE MAJORS AT THE UNIVERSITY OF UTAH

| Test | Biological Sciences Sr. | Business Sr. | Education Sr. | Engineering Sr. | Social Sciences Sr. | Medicine Soph. | Pharmacy Sr. |
|---|---|---|---|---|---|---|---|
| | N=52 | N=90 | N=123 | N=92 | N=85 | N=49 | N=101 |
| G | .307 | .506 | .372 | .516 | .537 | .471 | .396 |
| V | .410 | .613 | .344 | .349 | .532 | .453 | .315 |
| N | .220 | .374 | .350 | .350 | .454 | .393 | .315 |
| S | .151 | .196 | .163 | .249 | .196 | .412 | .194 |
| Q | .356 | .308 | .353 | .327 | .535 | .140 | .262 |

for general college success regardless of field of specialization, and also OAP's for seven academic areas in the University; namely, Biological Sciences, Business, Education, Social Sciences, Engineering, Pharmacy, and Medicine.[1]

The project staff recommended that, "there is a need for supporting studies at other universities to ascertain the

[1] Ibid., p. 144.

TABLE III

OCCUPATIONAL APTITUDE PATTERN FOR SEVEN COLLEGE MAJORS, UNIVERSITY OF UTAH

| Academic Area | Selected Aptitudes | Cut-off Score |
|---|---|---|
| Biological Sciences | G | 116 |
| | V | 112 |
| Business | G | 121 |
| | V | 111 |
| | N | 119 |
| Education | G | 110 |
| | V | 109 |
| | Q | 102 |
| Engineering | G | 129 |
| | V | 113 |
| | N | 123 |
| | S | 118 |
| Social Science | G | 110 |
| | V | 113 |
| Medicine | G | 131 |
| | V | 123 |
| | N | 120 |
| | S | 117 |
| Pharmacy | G | 119 |
| | V | 107 |
| | N | 123 |

extent to which the results of this study are representative of colleges and universities throughout the nation.[1]

A second study which took place at the University of Utah in 1948 constituted an exploratory step in a project designed to discover the relationship between GATB scores and subsequent general college success. The 1,291 students reported in this study were those who began at the University during the winter quarter of 1948. The coefficients of correlation in this study were based on six GATB test scores (G, V, N, S, Q, P) correlated against the first quarter grade-point-average. The first quarter grade-point-average had been shown to be a good predictor of scholastic success at this University. The correlations between the GATB scores and first quarter grade-point-averages are shown in Table IV.[2]

On the basis of the findings of this research study, the project staff concluded that "the tests show considerable promise as quick, easily obtained predictors of college success."[3]

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[1] Ibid.

[2] Frank P. Vex and Keith R. Sorenson, "GATB Scores as Predictors of College Grades," Personnel & Guidance Journal, XXXI (February, 1953), 295-297.

[3] Ibid., p. 297.

TABLE IV

CORRELATIONS BETWEEN GATB SCORES AND FIRST QUARTER GRADE POINT AVERAGES FOR ENTERING FRESHMEN STUDENTS AT THE UNIVERSITY OF UTAH IN 1948

| Women | | | Men | | |
|---|---|---|---|---|---|
| N = 515 | | | N = 776 | | |
| Sub-Test | r | $SE_r$ | Sub-Test | r | $SE_r$ |
| G | .41 | .036 | G | .43 | .029 |
| V | .34 | .039 | V | .43 | .029 |
| N | .30 | .040 | N | .37 | .031 |
| S | .17 | .043 | S | .20 | .034 |
| Q | .40 | .043 | Q | .27 | .039 |
| R | .15 | .043 | R | .29 | .033 |

In 1952 the University of Florida in cooperation with the Florida State Employment Security Commission and the United States Employment Security Commission conducted a research study using the GATB. Their study was quite similar to that of the one conducted by the GATB project staff at the University of Utah in 1948 with the exception that the University of Florida studied the schools of Architecture, graduate school for Psychology, and the schools of Forestry and Pharmacy. The correlations yielded in the school of Architecture

and the graduate school for Psychology were positive and, according to the author, could be recommended for guidance purposes.[1] In contrast, the schools of Forestry and Pharmacy showed positive but low correlations which, as the author stated, "suggests that use for prediction purposes is undesirable."[2]

Utah State University conducted a study in which 262 college juniors, seniors, and some students who had been graduated the previous June were used as subjects. In this study nine aptitudes of the GATB were correlated against the students' cumulative grade-point-average. The students used in this study were from the schools of Engineering, Business Administration, Education, and Physical Education. The results of the total sample of this study are shown in Table V.[3]

The directors of the Utah State study found that, "there was no advantage in using grade-point-average from selected courses in a chosen field over the total cumulative grade-point average."[4] A second finding was that,

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[1]Sibyll Storz, "Evaluative Data on the GATB," Personnel & Guidance Journal, XXVIII (November, 1952), 87-88.

[2]Ibid., p. 88.

[3]H. C. Sharp, "GATB Scores as Predictors of Success in College," Educational and Psychological Measurement, XIX (Winter, 1959), 617-623.

[4]Ibid., p. 623.

TABLE V

MEAN AND PEARSON PRODUCT-MOMENT CORRELATIONS BETWEEN THE APTITUDES OF THE GATB AND THE GRADE-POINT-AVERAGE OF 262 STUDENTS IN ENGINEERING AT UTAH STATE UNIVERSITY IN 1948

| Aptitude | Mean | r |
|---|---|---|
| G | 107 | .381** |
| V | 103 | .459** |
| N | 104 | .396** |
| S | 110 | .148* |
| P | 113 | .343** |
| Q | 107 | .391** |
| K | 109 | .277** |
| F | 99 | .235** |
| M | 107 | .038 |

* Significant at .05 level of confidence.

** Significant at .01 level of confidence.

"students who are successful in engineering course work (GPA's of 2.10) score significantly higher in G, V, N, S, and P aptitudes and lower in the M aptitude than students who fell below 2.10 grade-point-average.[1]

[1] Ibid.

The latest studies this writer could find using the GATB were two 1963 studies, one in California and the other in Wisconsin. In the Wisconsin study the sample used was 102 employed workers in business programming. The criterion against which the GATB was correlated was supervisor ratings. A coefficient of .35 was found.[1]

In the California study ninety-three employed workers were used as the experimental sample. Supervisor ratings were also the criterion against which the GATB test scores were correlated. A phi coefficient of .31 was found in this California study. An occupational aptitude pattern was derived in which cut-off scores of G-115, V-105, N-110, and S-105 were found.[2]

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[1] United States Department of Labor, Catalog of Tests and Test Materials: December 1964 (Washington: Government Printing Office, 1965), p. IA 3-281.

[2] Ibid.

# CHAPTER III

## DESCRIPTION OF RESEARCH PROCEDURE

### I. SAMPLE AND POPULATION

Subjects selected for this study were students at the Manpower Development and Training center in Ottumwa, Iowa (Iowa Technical Education Center, Iowa Tech). They were selected for training by the Employment Security Commission offices in Iowa, North Dakota, South Dakota, Nebraska, Kansas, and Missouri. Ninety-three students from the first five classes enrolled in the school were used in this study. Fifteen of the original ninety-three students left the school for one reason or another before they were assigned a first quarter grade. The Employment Security Commission offices selected these students from the ranks of the unemployed and underemployed. For this reason, it should not be assumed that the sample was typical of students in business programming courses across the nation.

A characteristic of the Ottumwa Training Center which forced the investigator to compute correlations for grade-point averages for each quarter rather than just the cumulative grade-point average, was that the majority of the students tested did not graduate. Due to the demand for

programmers, many of the students were placed on a job before graduation. Because of this, and because of the approximately 30 per cent attrition rate at the school, only about 35 per cent of the students who enroll actually graduate. The school records indicated that the cause of the 30 per cent attrition rate was about evenly split between difficulty of training and personal and/or financial problems.

A person usually thinks of students in training being from about eighteen to twenty-two years of age. The mean age of the subjects used in this study, however, was 26.83 years, with a standard deviation of 6.97 years.

## II. TESTING INSTRUMENTS USED

The instruments used for testing the subjects were the Programmer's Aptitude Test (PAT) and the General Aptitude Test Battery (GATB). The PAT was used because of its almost universal acceptance by industry as a screening device for business programmers. The PAT is a one hour test, the purpose of which is to determine a person's ability to think logically. It is broken into three parts. The first part is a ten-minute test in which a series of numbers is set up and the subject is to select the next logical step in the series. The second part is a twenty-minute test of spatial visualization. The third part is a thirty-minute test of arithmetical

reasoning. The test score is obtained by using a mathematical formula of number right minus one-quarter the number wrong. The maximum attainable score is eighty-six. Sixty and above constitutes an "A," from fifty through fifty-nine is a "B," from forty through forty-nine is a "C," and below forty is considered a "D."[1]

General Aptitude Test Battery (GATB) scores were furnished the school by the Employment Security Commission offices at the time the student began training. Because the school had the scores on file and the Employment Security Commission needed research of this type, the writer decided to use this test in his study. The GATB has been used extensively by the United States Employment Security Commission for several years and an abundance of research has been done with it. The GATB consists of a battery of nine different tests, each of which is designed to measure a particular aptitude. The aptitudes used in this study are described by subtests, and were singled out as possible predictors of achievement. Research by the investigator failed to reveal how these subtests were selected as predictors of achievement. The investigator assumes that the 1963 California and Wisconsin studies cited in Chapter II of this report were the ones used in the selection procedure. The usual method

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[1]International Business Machines Corporation, op. cit., p. 2.

employed by the Employment Security Commission is to make a job analysis in which particular attention is paid to the aptitudes involved in performing the job, give employed workers the GATB, find the mean scores for the aptitudes found significant in the job analysis, and from the mean scores establish an occupational aptitude pattern. The subtests selected for business programming were: G - General Intelligence, V - Verbal Aptitude, N - Numerical Reasoning, and S - Spatial Relations.

## III. METHODS AND PROCEDURES

The Employment Security Commission office which referred a student for training administered the GATB and forwarded the scores to the Iowa Technical Education Center. The G, V, N, and S subtest scores from the GATB were used in the study. The IBM Programmer's Aptitude Test was given after the students' arrival at the training center and was included in the study. The other factor considered was the students' ages. To determine the success of these six different variables in predicting success in training, the grade-point-averages for each quarter were used to calculate the cumulative grade-point-average. The grade-point-averages, both quarter and cumulative, were used as dependent variables. The mean number of quarters work completed by the seventy-eight subjects studied was 2.63, with a standard deviation of 1.18.

To predict success in data processing, a multiple regression analysis was run by computer. The criterion variable used was cumulative grade-point-average. The independent variables were age, GATB G, V, N, and S scores, and the PAT score. After the first multiple correlation was found, using the above-mentioned independent variables, the beta weights were examined. A beta weight is a part of a mathematical formula which is used to delete the non-significant numbers of a correlation. A step-down deletion process was employed in which non-significant variables were dropped. The smallest non-significant beta weight indicated the deletion in each phase of the step-down procedure until only statistically significant beta weights remained, or until there was a significant change in multiple correlations.

The Pearson Product-Moment correlation was used as a measure of the relationship between individual predictor variables and the criterion grade-point-average.

## IV. RESULTS

Table VI shows the result of the multiple regression analysis. The only predictors to remain in the multiple correlation were the PAT and the GATB N score. The initial correlation was 0.5669 and the final correlation was 0.5160.

However, a closer examination of Table VI shows that the beta weight for N was not significant at the .05 level of confidence. Although N as a single order correlation was a significant predictor at the .01 level (see Table VII), in the multiple regression analysis, it did not add significantly to the predictive efficiency established by the PAT.

TABLE VI

MULTIPLE R'S, BETA WEIGHTS, AND F'S RESULTING FROM REGRESSION ANALYSIS USING A COMBINATION OF GATB (G,V,N,S), PAT, AND AGE AS INDEPENDENT VARIABLES WITH THE DEPENDENT VARIABLE OF CUMULATIVE GRADE-POINT-AVERAGE

| Independent Variables | Beta Weights | F's for B's | Beta Weights (b) |
|---|---|---|---|
| P.A.T. | .34354 | 6.2917 | .02435 |
| Numerical (GATB) | .24009 | 3.0729 | .01946 |
| | | ($F_{.05}$=4.02 | |

$R^2$ = .2662, F =10.160, $F_{.05}$=3.1700

R =.5160

Initial $R^2$ = .3214, F =4.105, $F_{.05}$= 2.2900

Initial R = .5669

Constant term, a = -1.215

N = 59

It is interesting to note here that the G, V, and S scores of the GATB were dropped out of the multiple correlation, and that the N did not remain significant. This would suggest that the GATB, for this sample at least, is highly inefficient for predicting success in business programming training. It is the opinion of the writer that there are other test batteries which would have more predictive efficiency than the GATB. One possibility suggested by Malone's study is the Dailey Vocational Test.[1]

TABLE VII

PRODUCT MOMENT CORRELATIONS BETWEEN INDEPENDENT VARIABLES AND DEPENDENT VARIABLES

| Independent Variable | N | r | Significance Level |
|---|---|---|---|
| Age | 77 | -0.0038 | |
| G | 76 | 0.3737 | .01 |
| V | 76 | 0.2844 | .02 |
| N | 76 | 0.4735 | .01 |
| S | 75 | -0.0236 | |
| PAT | 60 | 0.5257 | .01 |

[1]Malone, op. cit., p. 174.

The multiple regression analysis done by Malone[1] pointed out that the best selection criteria for entrance into data-processing training would be to select students on the basis of high school grade-point-average, high school commercial grade-point-average, and Dailey Vocational Test mechanical and electronics scores. Even though he came up with a high multiple correlation (.80), this system is almost impossible to use. The writer has noted from his three years' experience in counseling programming students that very few of these students had high grade-point-averages. Many of them had high I.Q. scores and were good in Mathematics but did not make high grades in all courses. This selection criterion would be of value, therefore, in only a few cases.

The conclusion made by McIntosh and Windholz[2] in their North Carolina study that the G score was the best single predictor in the GATB, was not supported. Although the difference between the correlation of the G score with cumulative grade-point-average and the N score with cumulative grade-point-average was not significant at the .05 level, it was in the opposite direction suggested by McIntosh and Windholz.

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[1] Ibid., Table 33.

[2] McIntosh and Windholz, loc. cit.

From Table VII it is interesting to note the almost complete absence of any relationship of the predictor criterion of both age and the GATB S score.

In an attempt to discover the nature of the relationship between the PAT and success in business programming, the test for linearity of regression was run. An F of 1.346 was obtained which is not significant at the .10 level. The conclusion can therefore be made that the relationship between the PAT and cumulative grade-point-average does not deviate from the linear regression line, and that the product moment correlation is the best measure of relationship (see Table VIII).

TABLE VIII

TEST FOR LINEARITY OF REGRESSION BETWEEN THE PAT AND CUMULATIVE GRADE-POINT-AVERAGE

| Source of Variation | Sum of Square | df | Mean Square | F |
|---|---|---|---|---|
| Linear Regression | 13.83 | 1 | 13.83 | |
| Deviation from Regression | 3.03 | 4 | .7575 | 1.346 |
| Between columns | 16.86 | 5 | 3.372 | |
| Within columns | 30.39 | 54 | .5628 | |

F - 2.56 Significant at .10 level

F - 3.72 Significant at .02 level

TABLE X

ALL POSSIBLE PEARSON PRODUCT-MOMENT CORRELATIONS BETWEEN VARIABLES IN THIS STUDY

| | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Age | .228 | .274* | .07 | .07 | .00 | .027 | -.139 | .12 | .346 | -.004 | -.07 | r |
| | 75 | 75 | 75 | 74 | 59 | 77 | 57 | 43 | 25 | 77 | 77 | n |
| 2. G | | .757** | .739** | .663** | .725** | .42** | .175 | .167 | .228 | .374** | .335** | r |
| | | 76 | 76 | 75 | 60 | 76 | 58 | 44 | 25 | 76 | 76 | n |
| 3. V | | | .457** | .294* | .517** | .332** | .06 | .087 | .209 | .284* | .288* | r |
| | | | 76 | 75 | 60 | 76 | 58 | 44 | 25 | 76 | 76 | n |
| 4. N | | | | .24* | .573** | .436** | .49** | .42** | .435** | .474** | .316** | r |
| | | | | 75 | 60 | 76 | 58 | 44 | 25 | 76 | 76 | n |
| 5. S | | | | | .446** | .025 | -.184 | -.208 | -.136 | -.024 | -.122 | r |
| | | | | | 59 | 75 | 58 | 44 | 25 | 75 | 75 | n |
| 6. PAT | | | | | | .558** | .345* | .299 | .00 | .526** | .501** | r |
| | | | | | | 60 | 46 | 28 | 19 | 60 | 60 | n |
| 7. 1st Quarter. GPA | | | | | | | .809** | .70** | .384* | .931** | .825** | r |
| | | | | | | | 58 | 44 | 25 | 78 | 78 | n |
| 8. 2nd Quarter. GPA | | | | | | | | .825** | .389* | .937** | .443** | r |
| | | | | | | | | 44 | 25 | 58 | 58 | n |

TABLE X--(Continued)

| | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9. 3rd Quarter. GPA | | | | | | | | | .665** | .944** | -.06 | r |
| | | | | | | | | | 25 | 44 | 44 | n |
| 10. 4th Quarter. GPA | | | | | | | | | | .755** | .00 | r |
| | | | | | | | | | | 25 | | n |
| 11. Cumulative GPA | | | | | | | | | | | .524** | r |
| | | | | | | | | | | | 78 | n |
| 12. Quarters in School | | | | | | | | | | | | |

* Significant at .05 level of confidence.

** Significant at .01 level of confidence.

# CHAPTER IV

## SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

It was the purpose of this study to determine the effectiveness of six variables: test scores of the Programmer's Aptitude Test; the G (General Intelligence), V (Verbal Ability), N (Numerical Reasoning), S (Spatial Relations), scores on the General Aptitude Test Battery; and student's age, in predicting success in training for business programming students at the Iowa Technical Education Center, Ottumwa, Iowa.

The subjects used in this study were seventy-eight business programming students taking training at the Iowa Technical Education Center in Ottumwa, Iowa. These students were selected by the Employment Security Commission offices in six different states, the students' training costs being paid from Federal Manpower Development and Training Act funds. The Employment Security Commission offices used the General Aptitude Test Battery as a screening device for students desirous of taking the business programming training and the results of these tests were sent to the Iowa Technical Education Center upon the students' entrance. The students were administered the Programmer's Aptitude Test by the Iowa Technical Education Center and the scores made

on these tests were used, along with the subjects' age, in this study.

To determine the ability of the above-mentioned variables to predict success in business programming training, the six variables were correlated against the criterion grade-point average. A multiple regression analysis was also run on the computer. This was done to see if there were a combination of these six variables that would yield a significantly higher correlation than any one individual variable.

The single order correlations yielded three scores which were significant at the .01 level of confidence. The highest of these scores was the PAT which correlated at .5257. The second highest predictor variable was the N score on the GATB which yielded a .4735 correlation that was .0998 higher than the correlation yielded by the G score (.3737). The only other predictor variable yielding a positive correlation was the V score on the GATB which came out .2844 which was significant at the .02 level of confidence. The S score on the GATB and the students' age yielded small negative correlations. The initial correlation of the multiple regression analysis, which was a combination of the predictive ability of all six variables, was .5669. The only predictors to remain in the multiple correlation were the PAT and the GATB N score. These two

predictors yielded a final correlation of .5160. Close examination revealed that the beta weight for the N score was not significant at the .05 level. Although the N score was significant at the .01 level in the single order correlation it did not add significantly to the predictive efficiency established by the PAT in the multiple regression analysis.

## I. CONCLUSIONS

Based upon the results of this study, the writer concludes that for this sample:

1. Age had no predictive value in determining success in business programming training.
2. The GATB seems to be an ineffective test battery when used to attempt to predict success in business programming.
3. The PAT seems to be a good predictor of success in business programming training. It proved to be the best predictor for both cumulative grade-point-average and probability of finishing the program.

# II. RECOMMENDATIONS

The writer recommends that:

1. Follow-up research be done using the PAT in combination with the Dailey Vocational Test and high school achievement indices.
2. Follow-up research be done using the PAT as the predictor variable and supervisors' ratings of the graduates studied as the dependent variable.
3. The same study be continued with following classes at the Iowa Technical Education Center to obtain a larger norm group on which to establish correlations.

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